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Milk Utilization Efficiency of Multi-Genotypes Cattle under Two Divergent Climatic Gradients in Nigeria: Low And High Altitudes

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ABSTRACT

The study investigated the milk utilization efficiency of Multi-breed cattle under two divergent altitudes in Nigeria. Data were sourced from 1448 lactating cows in two commercial farms (Shonga and West Africa Milk Company Integrated Dairy Limited) under two divergent weather system in Nigeria. All statistical analyses were done using R-commander statistical software. Significant differences in means were separated using Tukey's test. The effect of genotype was significant (P<0.05) on 305 d fat yield, protein yield and lactation length, accounting for 37.03, 41.13 and 8.84 % of the total sources of variation, respectively. Genetic group effect was highly significant (P<0.01) on milk efficiency traits (FCMKgW, FCMKgMW, FCM/day/kgW, FCM/day/kgMW, net energy efficiency and dairy merit) under low altitude conditions. Under high altitude conditions, milk production and efficiency traits were greatly influenced (P<0.01) by the cow genotype with the exception of total solid. The mean FCMKgW, FCMKgMW, FCM/day/kgW, FCM/day/kgMW, net energy efficiency and dairy merit for the combined genotypes were 6.9±0.16 kg, 33.3±0.74 kg, 0.02±0.005 kg, 0.1±0.02 kg, 52.6±0.55 % and 73.0±0.47 %, respectively. It was concluded that Jersey breed was more efficient for milk production under low altitude while Holstein pure bred cows performed excellently well under high altitude in Nigeria.

Keywords: *milk production efficiency, lactoscan, fat corrected milk yield, milk components*

INTRODUCTION

Genotype by environment interaction is a hot issue in dairy industry due to the globalization of using artificial insemination with genetically superior bulls to upgrade the performance of cows in their herds. This includes distribution of genetic material to multiple environments within countries and between countries. The major concern is that animal rank may change across the environments which means that the best animals in one environment may not be the best in another environment. The importance of breed efficiency has received attention in the dairy industry. Several researchers (Akpa et al., 2001) reported no comparative advantage for different breeds, inspite of higher ratios of milk to body weight and feed intake. Recently, milking efficiency, feed and production efficiency in dairy cows has become an important function in the dairy industry globally (Prendiville et al., 2011). Therefore, this study investigated the efficiency of milk production of different genetic groups of dairy cattle in Nigeria.

MATERIALS AND METHODS

Lactation data from 1448 lactating cows were sourced from two commercial farms (Shonga and West Africa Milk Company Integrated Dairy Limited) under two divergent weather systems in Nigeria. Shonga dairy farm is situated in Edu local Government (Kwara state, Nigeria) with an altitude of 205m (Low altitude). Integrated Dairies Limited (WAMCOIDL) is located on the plateau at an altitude of 1280m above sea level (High altitude). Four multi-breed cattle consisting of two purebred (Holstein and Jersey) and two crossbred cows (HolsteinXBunaji and JerseyXBunaji) belonging to different herds were used for the study. The cows were kept out doors in paddocks all year round except during the morning and after-noon milking. Routine health and management practices were carried out as at when due.

Parameter Estimations

Fat and protein content of the milk were estimated using Lacto scan machine. Fat and protein percentage were multiply by the average milk yield. Lactation length was estimated as the total number of days the cow spent on milking.

Fat corrected milk yield= [(0.4*milk yield (kg) + [(15*fat yield (kg)] (Gains, 1928)

$$FCM / kgW = \frac{FCM}{W}$$, where w=body weight (kg);

$$FCM / kgMW = \frac{FCM}{M^{0.75}}$$, where MW=Metabolic bodyweight (kg) and 0.75 is the power function for calculating MW

$$FCM / day / kgMW = \frac{FCM / day}{W^{0.75}} \quad FCM / day / kgW = \frac{FCM / day}{W}$$

$$Netenergyefficiency\,(NEE)(\%) = \frac{750 * FCM / day * 100}{(750 * FCM / day) + 70W^{0.75}}$$, where 750=kilocalories of energy per kg of FCM and 70= Basal metabolic rate

$$DairyMerit(DM)(\%) = \frac{NEE * FCM / day}{FCM / day + 0.173W^{0.75}}$$

Statistical Data Analyses

All statistical analyses were done using R-commander statistical software. Significant differences in means were separated using Tukey's test.

Results And Discussion

Least squares means for the thirteen milk measures across the four genotypes in low altitude environment are presented in Table 1. Milk production and efficiency traits were influenced (P<0.01) by the cow genotype in Kwara, except total solid. The average 305 day fat corrected milk yield (305dFCM) 2208.7 observed in the low altitude environment is higher than the results of Ngongoni et al. (2006) of 2015 kg for cows in Zimbabwe. This obvious difference may be attributed to different breeding practices employed by different herds in different countries. The observed 305 fat corrected milk yield per cow per day (305MY/cow/ d) 6.7 kg was higher than 8.9 kg reported by Ángel Ríos-Utrera (2013) for dairy cows under subtropical conditions. These differences were probably due to the size of the dairy herds, different management systems and to true breed differences. The observed fat yield (FY) and protein yield (PY) 44.5 and 35.6 kg were lower than the values of 273.9 and 237.3 kg (Jóźwik et al., 2012) in medium producing dairy cows and 346.8 and 339.5 kg (Jóźwik et al., 2012) in high producing dairy cows in Czech Republic. The differences might be due to large changes in milk composition in the past decades in many countries due to changes in feeding, breeding and cattle management practices. The total solid (TS) 12.4% was approximately similar to 13% reported in central Ethiopia for dairy cows (Anyalem et al., 2008). The mean lactation length (LL) of 331.9 days was a function of the quantity of milk produced by the cows. The 4.2 kg FCM/kgW obtained in this study was less than 6.66kg and 7.01kg reported for Friesian and Jersey dairy cows, respectively (Rao and Nagarceukar, 1979). The present net energy efficiency (NEE) of 39.7% was higher than 30.1% reported for Zebu cattle in Nigeria (Ibeawuchi, 1993). This implied that 42.4% energy of the total digestible nutrient (TDN) in feed, exclusive of maintenance was recovered in milk produced.

Table 2 shows the least squares means of the thirteen milk measures between the two genetic groups in the high altitude. Milk production and efficiency traits were influenced (P<0.01) by the genotype of the cows in the Plateau, except total solid. Holstein purebred cows significantly had higher performance for milk production and efficiency traits than Holstein X Bunaji cows. This implies that animals showed more adaptation to the mountainous climate which made them less aware of heat stress, thus initiating milk production at optimal level. The mean 305dFCM yield per lactation in this study is higher than 11.06 kg reported by Million and Tadelle (2003) in Ethiopia for Holstein cows. The mean 305dFCM yield per lactation in the developed countries is much higher than in developing countries (average 40 kg; Ranawana, 2008).

Table1. *Least squares means (±standard error) and coefficient of variation of milk production and efficiency traits among different groups of dairy cows in low altitude environment*

Traits	Holstein (n=219)	HXB(n=210)	Jersey (n=230)	JXB (n=234)	Overall (n=893)	CV, %	SEM
305 FCM (kg)	2163.0±13.11b	1937.6±13.14c	2411.8±56.66 a	1810.5±18.34c	2208.7±39.79	36.76	102.84
305 FCM /c/ d(kg)	6.6±0.25a	6.1±0.22a	7.2±0.31a	5.3±0.16b	6.7±0.51	20.12	0.85
100d FCM (kg)	1085.9±12.12a	888.1±11.61b	758.5±10.81d	812.1±14.72c	840.4±9.93	33.72	25.56
305d Fat yield (kg)	41.2±0.66a	32.3±0.62b	52.2±2.29 a	33.2±0.92b	44.5±1.60	37.03	6.48
305d PY(kg)	42.2±0.68a	36.2±0.75b	33.1±1.27b	28.6±1.16c	35.6±0.58	41.13	1.50
Total solid	12.2±0.08	12.6±0.09	12.5±0.09	12.6±0.09	12.4±0.05	6.48	0.40
Lactation length	329.6±0.08b	319.9±1.18c	335.6±2.25b	341.9±4.16a	331.9±1.16	8.84	3.40
FCM Kg W	3.9±0.05b	3.2±0.04c	4.8±0.20a	3.4±0.12c	4.2±0.14	50.17	0.30
FCM Kg MW	18.5±0.17b	15.4±0.15c	22.1±0.78 a	15.8±0.42c	19.6±0.55	45.06	1.21
FCM/day/kgW	0.04±0.01b	0.06±0.01a	0.02±0.01c	0.06±0.01a	0.01±0.003	50.17	0.01
FCM/day/kgMW	0.01±0.001 b	0.01±0.001b	0.02±0.01a	0.02±0.001a	0.01±0.001	45.06	0.005
NEE (%)	39.3±0.20ab	35.1±0.24b	42.6±0.80a	35.4±0.60b	39.7±0.61	33.06	2.45
Dairy Merit (%)	57.7±0.16 a	54.6±.0.17 b	60.6±0.64 a	54.8±0.25b	58.3±0.46	23.91	2.19

a,b,c,d Means under the same trait with different superscripts differ significantly (P<0.05); d-days; FCM-Fat corrected milk; kg-kilogram; MW-Metabolic weight; W-Weight; NEE –Net energy efficiency; CV-Coefficient of variation; SEM-Standard error of mean; PY-Protein yield;c-cow

Table2. *Least squares means (±standard error) and coefficient of variation of milk production and efficiency traits among different genetic groups of dairy cows in high altitude environment*

Traits	H (n=270)	HXB (n=285)	Overall (n=555)	CV (%)	SEM
305 FCM (kg)	4996.8±92.64[a]	3322.8±29.16[b]	4040.0±74.92	37.64	224.82
305FCM/cow/day (kg)	14.0±0.37[a]	8.9±0.06[b]	11.06±0.51	25.05	1.88
100d FCM (kg)	1585.3±20.34[a]	1221.6±13.46[b]	1345.7±46.94	50.42	50.47
305d Fat yield (kg)	151.6±3.94[a]	84.1±1.37[b]	116.2±3.04	37.83	14.16
305d protein yield (kg)	186.8±7.34[a]	110.3±3.44[b]	115.3±4.09	51.30	21.91
Total solid (g/100g)	12.2±0.07	12.4±0.08	12.3±0.05	6.33	0.39
Lactation length (days)	357.3±5.35[b]	372.6±4.72[a]	365.3±3.58	19.52	5.52
FCM Kg W	7.7±0.20 [a]	4.4±0.10 [b]	6.9±0.16	42.45	0.49
FCM Kg MW	37.1±0.89 [a]	21.22±0.42[b]	33.3±0.74	40.62	2.17
FCM/day/kgW	0.01±0.001[a]	0.3±0.001[b]	0.02±0.005	41.45	0.002
FCM/day/kgMW	0.1±0.02[a]	0.2±0.01[b]	0·1±0.02	40.62	0.01
NEE (%)	55.7±0.66[a]	42.27±0.49[b]	52.6±0.55	25.96	2.96
Dairy Merit (%)	75.6±0.61[a]	63.18±0.31[b]	73.0±0.47	14.75	2.56

[a,b] Means under the same trait with different superscripts differ significantly (P<0.05); d-days; FCM-Fat corrected milk; kg-kilogram; MW-Metabolic weight; W-Weight; NEE –Net energy efficiency; CV-Coefficient of variation; SEM-Standard error of mean

Conclusions

The use of Jersey breed under a low altitude climatic gradient and Holstein breed under a high altitude climate is the best option for dairy production in these ecological zones. The ability of ½ Holstein X ½ Bunaji, ½ Jersey X ½ Bunaji crosses to produce a significant amount of milk without consuming as much energy as the purebred Holstein and Jersey proved to be profitable in a crossbreeding program for genetic improvement in Nigeria.

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